SKETCHING, DRAWING AND BLUEPRINT READING

APPRENTICESHIP RELATED INSTRUCTION

Department of Education
Office of Vocational and Adult Education

BLUEPRINT READING

Apprentice Related Training Module

Eric Rice

1. *Axis* A straight line on which a body rotates.
2. *Convention* A generally accepted and practice way of doing something.
3. *Converse* Reversed in order.
4. *Extrapolate* To infer, project, extend or expand.
5. *Grid* A network of uniformly placed horizontal and vertical lines for locating point means of coordinates.
6. *Isometric* A drawing in which the three surfaces are in proportion but presented to viewer on an edge rather than a surface face.
7. *Oblique* A drawing where the front view is parallel to the projection plane but the c axis is neither perpendicular to nor parallel to the base.
8. *Orthographic* A drawing of a single view, taken on the flat plane or surface.
9. *Perspective* The type of drawing where objects appear as they do to your eyes with res to distance and position.
10. *Projection* A view (drawing) of an object.
11. *Ratio* The relationship in quantity, amount or size between two or more things.
12. *Standardize* To make things conform.
13. *Vanishing Point* The point at which the lines on a perspective drawing merge into horizon.

Sketching, Drawing and Blueprint Reading is one of ten booklets written as core instructi
terials for apprentices to use during the first or second years of apprenticeship related subj
ining. Nine of the booklets are about critical subject areas for apprentices, as determined
tional group of experts on apprenticeship and training. The tenth booklet introduces the o
oklets and explains how to use the materials in the instructional setting.

The materials are designed to be used with other related subjects instructional materials. T
n be employed in one of two ways: (1) the materials can be used as the total instructi
terials package for some trades, in subjects such as basic science, measurement, and workin
ganizations; or (2) they can be used as supplementary, introductory or practice materials in
ts such as basic mathematics, safety and an introduction to apprenticeship.

The booklets are written in a self-instructional, self-paced format. They can be used eithe
tructor-supervised or independent study arrangements. *Each booklet and each chapter is*
as a distinct unit and is addressed to a single major topic. This means that you or your inst
can select individual booklets or chapters without necessarily using every booklet or ev
apter within a booklet.

The booklets emphasize application of facts, concepts and skills. Material is presentec
eans of written information, visual illustration and applied example. The discussion for most
topics also includes an application section that requires you as a learner to demonstrate v
u are learning. In addition, each chapter contains a section entitled Self-Test Exercises that
ns questions, problems and exercises for you to work through as a final application of
owledge or skill and to show that you have mastered the materials.

The titles of the booklets in the core materials are:

1. *A Basic Core Curriculum*
2. *Introduction to Apprenticeship*
3. *Basic Mathematics*
4. *Basic Safety I*
5. *Basic Safety II*
6. *Basic Measurement*
7. *Sketching, Drawing and Blueprint Reading*
8. *Basic Physical Science*
9. *Working in Organizations*
10. *Interpersonal Skills and Communication*

hat Is This Booklet About?

cs covered in this volume are:

1. Lines, Symbols and Notation
2. Scale and Dimensions
3. Types of Drawings
4. Sketching
5. Blueprint Reading

at Must I Do To Complete My Work In This Booklet?

Working your way through this booklet will require you to read the text, to answer the s, to perform the exercises and to complete the pretest and posttest instruments. Exp nd about five hours working through the materials. The only resources you need to con r work in this booklet are: (1) a copy of the booklet; (2) a pencil or pen; and (3) about four ime.

The materials are written in a self-instructional, programmed format. You may work thr text, examples, and questions at your own pace and leisure. You need not complete your he booklet at one sitting.

Each chapter in the booklet is devoted to a single skill, competency or unit of knowledg eral format of the chapters is similar, with the following parts:

1. A *chapter overview* containing all the necessary information you need to know in or work through the chapter.
2. An *introduction* describing the knowledge or skill and the instructional objectives fo information.
3. *Principles, examples, and applications* presenting and explaining the content as well fering you practice opportunities to apply the information.
4. Additional *sources of information.*
5. A *self-test exercise* for applying the information under consideration.

This booklet concludes with an appendix that contains the answers to the pretest, the se rcises from each chapter and the posttest.

w Much Do I Know About The Subject As I Begin?

material

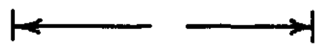
. Consider the questions and exercises in the text. Work the questions and check answers.
. When you believe that you have mastered the material, take the Self-Test at the end c chapter.
. Check your answers with those provided in the Appendix at the end of the booklet. I achieve at least the minimum acceptable score, move to the next chapter. If your sc below acceptable levels, work through the chapter again.

-Assessment Pretest

Directions: The self-assessment will help you focus on specific strengths and limitations of ching, drawing and blueprint reading knowledge and skills. Select the best answer for tion and record it in the appropriate space. After you have worked through the entire pr your test following the directions at the bottom of the test.

1. What is the meaning or use of the following line?

   Answer: ________________

2. What is the meaning or use of the following symbol? 

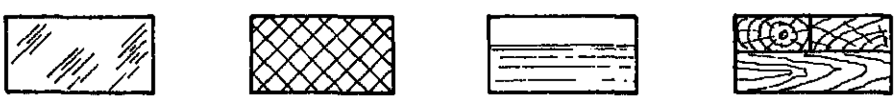
   Answer: ________________

3. Circle the letter of the following symbol that represents floor outlet.



a. b. c. d.

4. Circle the letter of the following symbol that represents sound and heat insulation.



a. b. c. d.

5. For what purposes are civil engineer's scales usually used?

   Answer:

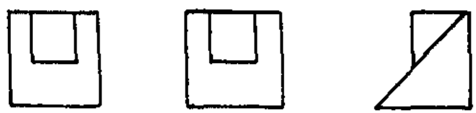
Answer: ______________

9. Circle the letter of the following item that is *not* a general convention for dimensionin
   a. Dimension lines are solid light lines terminated by arrowheads
   b. Dimensions that are larger are written larger than other dimensions
   c. Dimensions should be no smaller than 1/8"
   d. Dimensions are usually placed so they can be read from the bottom

10. Working drawings provide information about which of the following items (check all tl apply):
    a. Size and shape of object
    b. Location of component parts and features
    c. Materials specifications
    d. Fasteners, hardware, adhesives and other custom fasteners
    e. Finishing techniques and sometimes instructions

Examine the following drawings and match the type of drawing to the appropriate nai

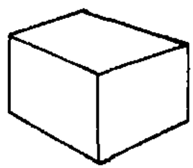
11. ______________



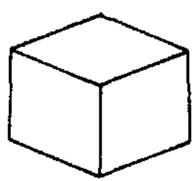
Possibilities:

a. oblique
b. orthographic
c. perspective
d. isometric
e. sectional
f. auxiliary

12. ______________



13. ______________



Chapter Overview

Purpose:	To insure that each apprentice has a working knowledge of funda- mental terms and conventions used in sketching, drawing and blueprint reading.
Preassessment Score:	Write in the following space the number of correct answers from Pre- test questions 1-4: ________. If you answered all 4 correctly, skip to Chapter 3. If you missed one or more questions, continue to work in this chapter.
Prerequisites:	Chapter 1 of this booklet.
Resources:	Time—At least 45 minutes to completion. Materials—pencil, paper
Performance Statement:	At the conclusion of this unit you will recognize, identify and use the major conventions for symbols, sketches, and blueprint reading.
Performance Measure:	A fifteen-minute paper and pencil test to be taken after completing the entire booklet.
Standards:	To be successful, you must answer at least 70% of the Posttest items correctly.
Activities:	1. Read the text, examples and illustrations and commit informa- tion to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-test Exercises and Posttest.

Introduction and Objectives

Sketches, drawings and blueprints, emphasize visual rather than narrative communic Shape, size and the location of parts of objects are the critical elements. Shape is illustrat lines; size is indicated by dimensions; and location is marked by symbols and lettering. E necessary for understanding, using and sketching working drawinqs on the job.

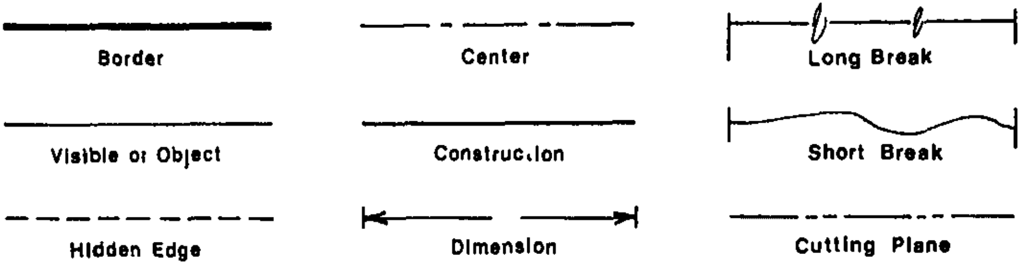
Fortunately for everyone who uses drawings and blueprints, the American Standards As

rinciples, Examples and Applications

ines

Drawings illustrate the shape of objects through the use of lines. There is an alphabet of l
r drawing, each with a different meaning. For example, the lines that mark the outside of an
ct are called object lines. They are thick, solid, heavy, dark lines that outline the external sh
an object. Conversely, edges hidden from view are represented by a thin, uniformly broken
he different types of lines used in job related drawings, sketches and blueprints are illustrate
igure 1. Carefully study the lines and their suggested uses.

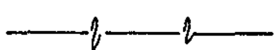
Figure 1. Types of Lines



dapted From: J. R. Lindbeck and I. T. Lathrop. *General Industry, 2nd Edition.* Peoria, IL: Charle
Bennet Co., 1977.

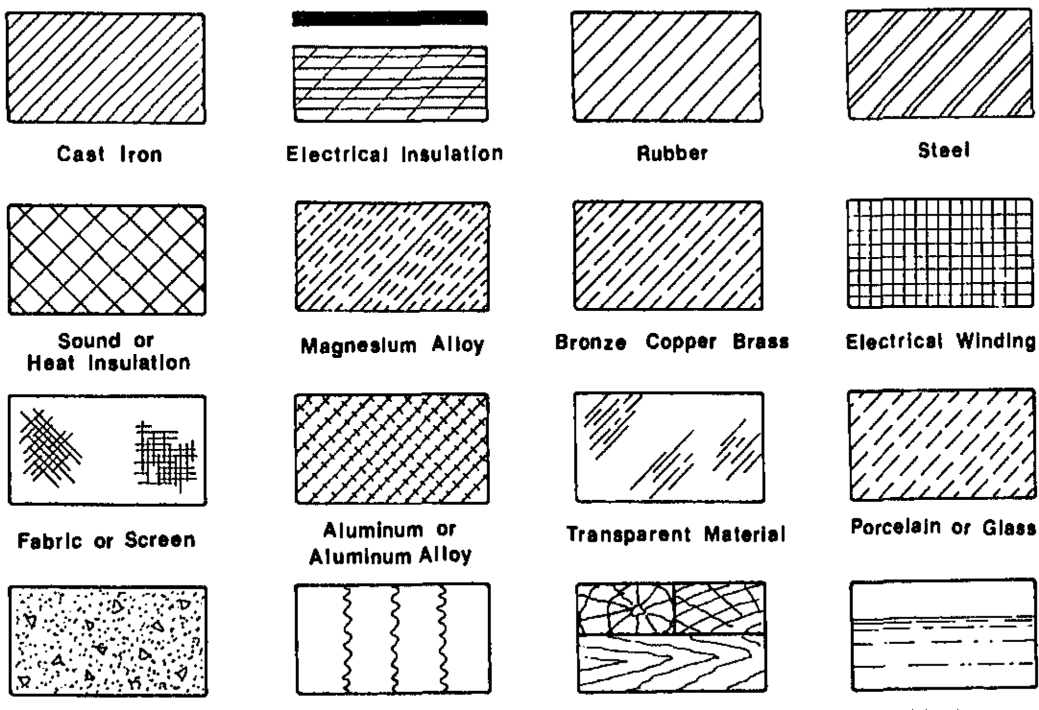
Without referring to the figure, identify the following types of lines:

1.

2. 

outlet, switch and box location. On a construction blueprint they indicate type of materi
used in parts of the structure while in installation and repair manuals they represent t
switches and valves. In Figure 2 are depicted basic construction materials and location s
while Figure 3 presents fundamental electrical symbols. Note that neither of the lists is co
only the more frequently used symbols are illustrated.

Figure 2. Basic Construction Graphic Symbols



Ceiling Lighting Outlet for recessed fixture (outline shows shape of fixture.)

Continuous Wireway for Fluorescent Lighting on ceiling, in covers, cornices, etc. (Extend rectangle to show length of installation.)

Lighting Outlet with Lamp Holder

(J) Junction Box

(D) Drop-Cord Equipped Outlet

(C) Clock Outlet

Switch Outlets

S Single Pole Switch

S_3 Three-Way Switch

S_4 Four-Way Switch

Miscellaneous

Service Panel

Distribution Panel

Switch Leg Indication connects outlets with control points.

(T) Thermostat

Duplex Convenience Outlet

3 Duplex Convenience Outlet (Substitute other numbers for other variations in number of plug positions.)

Duplex Convenience Outlet Split Wired

GR Duplex Convenience Outlet for Grounding-Type Plugs

WP Weatherproof Convenience Outlet

X Multi-Outlet Assembly (Extend arrows to limits of installation. Use appropriate symbol to indicate type of outlet. Also indicate spacing of outlets as X inches.)

S Combination Switch and Convenience Outlet

R Combination Radio and Convenience Outlet

Floor Outlet

R Range Outlet

DW Special Purpose Outlet. Use subscript letters to indicate function. DW Dishwasher, CD

(L)

Answer: ________________

Answers:

1. = Concrete
2. = Lap outlet

ttering

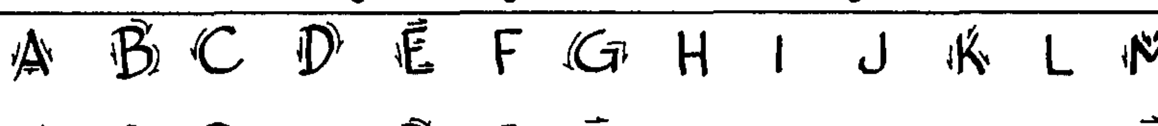
In addition to the shape and size of drawings, you also must label parts and views as well a
de explanatory notes. Information such as the name of the object, building materials and ty
hardware are critical. In order to include this information you must letter.

The style of lettering generally used is called "Single Stroke Gothic." It is printed such tha
ter touches any other letter. Letters may be in either lower (small) case or upper (capital)
es although upper case letters are more frequently used. In addition, letters generally
med using a slant of about 65° - 70°, about the normal slant for most handwriting. A
nally, the space between letters is only about a quarter as much space as is required to form
erage letter. The space between words is about twice that of the average letter. Also, remer
at when writing fractions, the numbers do not touch the line and the division line is locate
e center of the whole number.

Numbers can be drawn either at a slant or vertically, depending upon your own prefere
wever, the two styles may not be mixed on the same drawing. Whether you decide to use
al or slanted letters, do not hestiate to use guidelines to help insure uniform letter size. The r
portant thing to remember is that lettering must be neat and legible. Poor lettering can renc
ely-crafted drawing unusuable if the information cannot be read by a craftsworker.

Take a few minutes and study Figure 4. In this figure are illustrated each of the Single St
thic letters. The arrows indicate the general direction of the strokes for making each le
ke your pencil and trace over the letters. Then try your hand at forming each letter on a pie
atch paper.

Figure 4. Single Stroke Gothic Lettering



American Technical Society, 1973.

elf-test Exercises

Answer each of the following questions and compare your answers with those provided in ppendix of this booklet.

1. Match the letter of each of the following examples of lines with the number that represe their appropriate name.

a. 1. Hidden

b. 2. Object

c. 3. Center

2. Match the letter of each of the following symbols with the number that represents the s bol's appropriate name

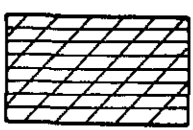
a. 

1. Fabric or Screw

b. 

2. Range Outlet

c.  3. Electric Insulation

d.  4. Multi-Outlet

Chapter Overview

Purpose:	To insure that each apprentice has a working knowledge of the scale and dimension conventions used in sketching, drawing and blueprint reading so as to enable workers to read, use and make job-related working drawings.
Preassessment Score:	Write in the following space the number of correct answers from Pretest questions 5-8: ________. If you answered all 4 correctly, skip to Chapter 4. If you missed one or more questions, continue to work in this chapter.
Prerequisites:	Chapter 1 of this booklet.
Resources:	Time—At least 45 minutes to completion. Materials—pencil
Performance Statement:	At the conclusion of your work in this chapter you will recognize, identify and use the major conventions for scales and dimensions in job-related working drawings.
Performance Measure:	A fifteen-minute paper-and-pencil test to be taken after completing the entire booklet.
Standards:	To be successful, you must answer at least 70% of the Posttest items correctly.
Activities:	1. Read the text, examples and illustrations and commit information to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-test Exercises and Posttest.

ntroduction and Objectives

Sketches, drawings and blueprints emphasize visual rather than written information; how

2. Critique and or label drawings appropriately in terms of scale and dimension.

rinciples, Examples and Applications

cale

The scale of a drawing is the ratio of the drawn object to its actual size. Scale is import ecause many times a sketch must be drawn smaller than the actual size of the object in orde : the picture onto a manageable sheet of paper. A house blueprint, a wiring diagram, or a work rawing of a new car design are typical examples of working drawings that usually are sca lown" from the actual size of the object. Conversely, drawings of small and complicated part any machines are drawn larger than actual size in order to emphasize required detail.

When drawing an illustration, select scale size so that (1) the drawing will fit on the paper ie drawing can be used conveniently; and (3) the detail can be depicted. Remember, an ropriately scaled drawing often is of more value than a full-size drawing.

The scale used in a drawing always should be indicated on the illustration. The most frequer sed scales in apprenticeable trades are the architect's scale, the mechanical engineer's scale ie civil engineer's scale. *While each tool looks very similar, the scale itself is graduated differer* r each instrument. The scales found on each instrument are illustrated in Figure 5.

Figure 5. Scales Found on Most Working Drawings in Apprenticeship

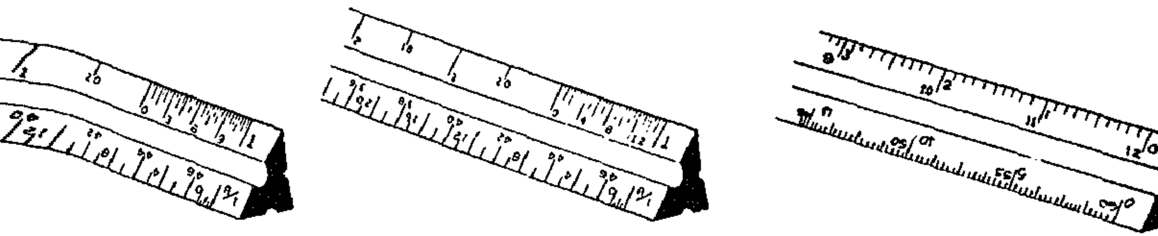
Architect's Scale	Mechanical Engineer's Scale	Civil Engineer's Scale
3/32 inch = 1 ft	1/8 of an inch = 1 in or 1 ft	1 inch = 1 foot or 10 ft
3/16 inch = 1 ft	1/4 of an inch = 1 in or 1 ft	1 inch = 2 feet or 20 ft
1/8 inch = 1 ft	3/8 of an inch = 1 in or 1 ft	1 inch = 3 feet or 30 ft
1/4 inch = 1 ft	1/2 of an inch = 1 in or 1 ft	1 inch = 4 feet or 40 ft
3/8 inch = 1 ft	1 = 1 ft	1 inch = 5 feet or 50 ft
3/4 inch = 1 ft	1.5 inches = 1 in or 1 ft	1 inch = 6 feet of 60 ft
1/2 inch = 1 ft	2 inches = 1 in or 1 ft	
1 inch = 1 ft	3 inches = 1 in	
1.5 inches = 1 ft		
3 inches = 1 ft		

…cted, the scale on any single drawing must be consistent for the entire drawing and m…
…ted (usually in the title) on the drawing.

…building industry the architect's scale is used most frequently. House plans often… …a scale of 1/4 inch equals 1 foot. In the manufacturing industry the mechanical engine… …sed most frequently. It is especially well suited for drawings with dimensions in fracti… The civil engineer's scale is used most often to depict large distances such as those… …th road and bridge construction or the layout of an entire subdivision.

…ally-used scales for each instrument are illustrated in Figure 6.

Figure 6. Typical Scales



Architect's Scale | Mechanical Engineer's Scale | Civil Engineer's Scale

…u will note in the figure, the architect's scale and mechanical engineer's scale are v… …he main difference is that the first is generally scaled in feet and the latter in inches. A… …eer's vernier scale contains 12 graduations representing inches while the mechanical … is made up of 16 graduations each representing one-sixteenth of an inch. The vern… …ovide a more accurate measurement.

…er the following questions about scale:

…w is scale defined? Answer: ________________

… what purposes are architect's scales generally used? Answer: ________________

…at are the three guideli…

ons and marks are used.

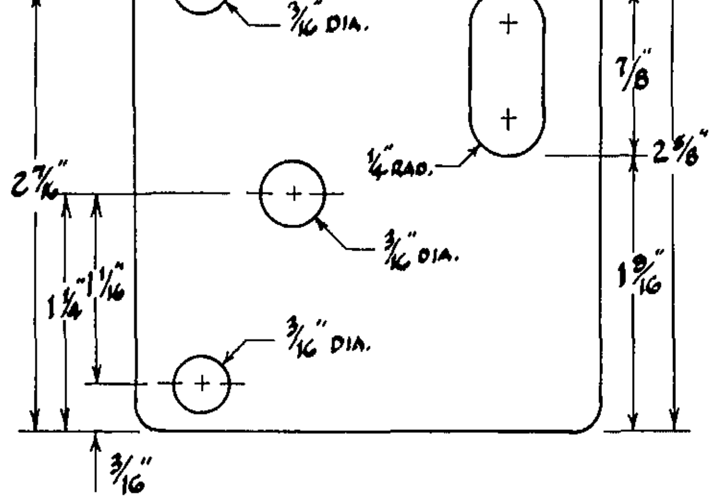
Frequently in manufacturing industries, the decimal system of dimensions is used. It provi r more exact control of manufactured parts. All figures on the drawing are shown as decim ne standard convention is to measure and indicate two-place decimals to the right of the deci oint with the second number always being an even number—.16, .82, .74—rather than an umber like, .67 or .05. The only exception to this convention occurs when greater precision in art is required. In such instances, 3-place and 4-place dimensions are used. A fraction-deci onversion chart is found in the Appendix of this booklet for your future reference.

Angle dimensions also are included on drawings. These dimensions are expressed in term egrees °, minutes ′ and seconds ″.

The size of an object is indicated by numbers placed within dimension lines on a draw imension lines are solid, light, thin lines terminated with arrowheads. They are located betw tension lines and placed on the drawing in a way that avoids confusion. This means the l sually are placed *beside* rather than *on* the illustration of the object. Extension lines do not to e object but rather are light lines that extend from the view of the object and bound the dim ons. Arrowhead points of the dimension lines touch the extension lines.

Stated as a set of general guidelines, the conventions for expressing dimensions as set forth e American Standards Association are as follows:

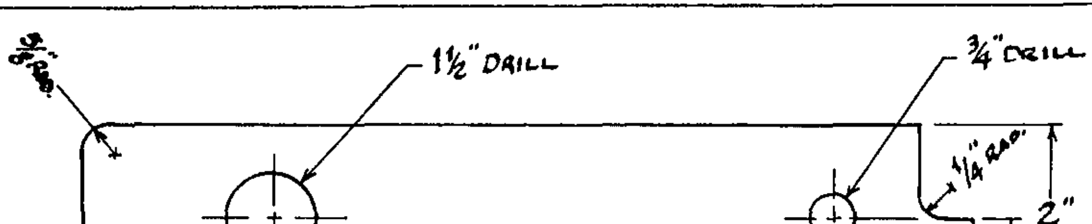
1. Dimension lines are solid, light lines terminated by arrowheads.
2. Arrowhead points touch the edge of the extension lines and usually are but 1/2″ lon
3. The dimension line is broken by a space in which the measurement figure is written.
4. The figure should be no smaller than 1/8″, but can be larger.
5. On any single drawing, all figures should be the same size.
6. Dimension lines usually are placed at least 3/8″ from the object drawing.
7. Extension lines begin about 1/16″ from the object drawing.
8. Extension lines are drawn at right angles to the location on the drawing to which t apply.
9. Dimensions usually are placed so they can be read from the bottom.
10. Dimensions are grouped together and arranged so that they produce an ord appearance.
11. Numerals are staggered, not less than 1/4″ apart so as to avoid confusion.
12. Fractions within dimensions usually are larger than whole numbers with each num about two-thirds the height of a whole number.
13. Do not repeat dimensions on the drawing.
14. Do not originate lines so that they will cross either extension or other dimension line
15. Do not originate or end dimensions on hidden lines.
16. The most important dimensions should be located with the principal or most impor



Size and location dimensions frequently are used when working with circles, arcs, and ang
 with straight lines, a set of conventions applies to dimensioning these figures. For exam
hen drawing holes and circles, always locate the centers by means of a center line. Then, by
nding the center line beyond the view of the object, use center lines in place of extension line
dicate location. Do not use these to indicate size. Recall that a center line is a vertical
rizontal line drawn with a pattern of a long line, a space and a dash. Repeat the patter
hatever length is necessary.

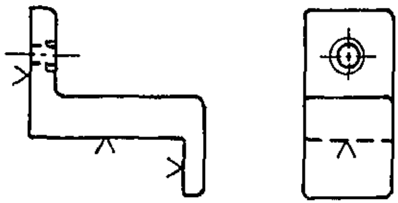
Always indicate the diameter of a circle or hole. You may indicate a radius for an arc, but
ameters for circles. Further, indicate diameters by using the letters DIA after the number;
 R after a radius figure. When indicating the diameter of a hole, point to the circle in questio
awing a line and arrow called a leader. Note that if the leader line were extended beyond the e
 the circle to which it refers, it would pass through the center of the circle. Fiqure 8 illustrates
ints about dimensioning circles.

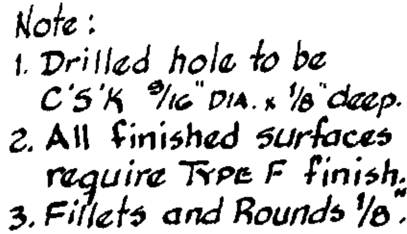
Figure 8. Circle Dimension Conventions



at the notes have numbers, have a heading and are very brief.

Figure 9. Shop Notes

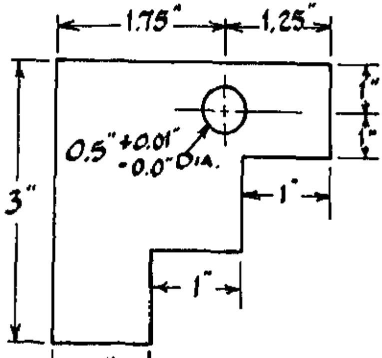


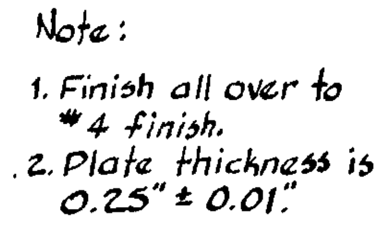


The allowable error in measurement is called the tolerance. It is the margin within which (abo d/or below) a measurement can vary and still be accurate enough for use. Usually tolerances a pressed as decimals and are included on the drawing. The more important conventions s unding tolerances are:

1. Specify tolerances in both the plus and minus directions. If these numbers are equal, th can be written and read as ±. If they are different, specify one number as plus and o number as minus.
2. If the numbers are different, place and read the high number above the low limit. If writt in the notes, the low limit figure will precede the high one.
3. If the question of tolerance is not an issue, do not include it on a working drawing that y are constructing.

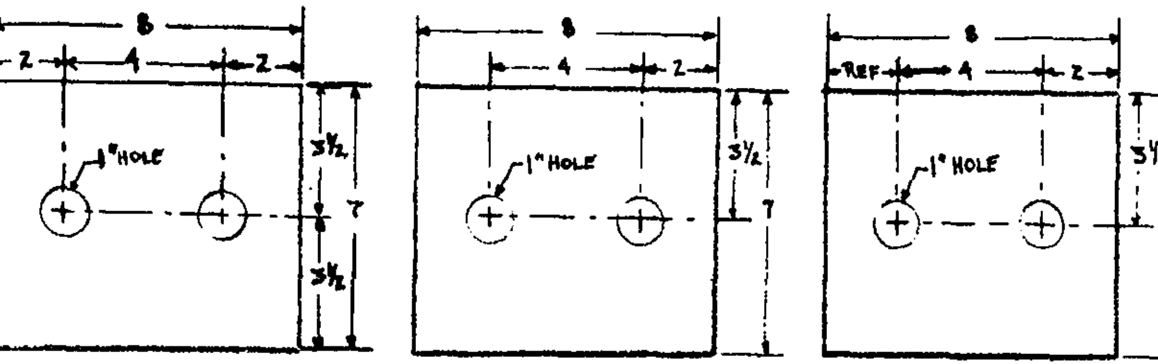
Figure 10. Tolerances





e top. Drawing C makes this even more clear by directing the worker to measure from the le right. The note "Ref." for reference means to measure from the other direction.

Figure 11. Measuring Tolerances



Acknowledging tolerances does not mean that inaccuracy is acceptable. Inaccuracy is wast d unacceptable. Tolerances simply allow for slight measurement error, due either to wo dgment or instrument problems.

Answer the following questions about dimensions:

1. Circle the letter of the dimension that probably is expressed incorrectly.

   A) 4 C) .32

   B) 6′ - 9″ D) 96″

2. What does the note ±2″ mean? Answer: ________________

Answers:

1. = D
2. = That the measurement has a tolerance of +2″ to −2″

...dditional Information

Answer: ____________________

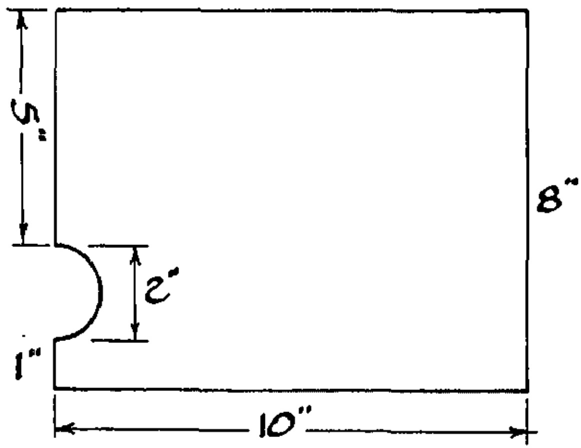
2. Why are some drawings made larger or smaller than actual size?

   Answer: ____________________

3. If you saw the dimension 5 on a figure, what would it mean?

   Answer: ____________________

4. Identify three rules of dimensioning which are violated in the following sketch?



   Answer: a. ____________________
   b. ____________________
   c. ____________________

5. Explain why tolerance is taken into account.

   Answer: ____________________

Chapter Overview

Purpose:	To insure that each apprentice recognizes and can interpret the various types of views in working drawings that frequently are encountered in the workplace.
Preassessment Score:	Write in the following space the number of correct answers from Pretest questions 10-13: ________. If you answered all 4 correctly, skip to Chapter 5. If you missed one or more questions, continue to work in this chapter.
Prerequisites:	Chapter 1, 2 and 3 of this booklet.
Resources:	Time—At least 30 minutes to completion. Materials—pencil
Performance Statement:	At the conclusion of this unit you will recognize, identify and explain the major characteristics of the types of working drawings used in work settings.
Performance Measure:	A fifteen-minute paper-and-pencil test to be taken after completing the entire booklet.
Standards:	To be successful, you must answer at least 70% of the Posttest items correctly.
Activities:	1. Read the text, examples and illustrations and commit information to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-test Exercises and Posttest.

Introduction and Objectives

Working drawings are made to be used. They provide sufficient information about an obje make, repair and/or use the object. They are absolutely essential for construction of almost product. Working drawings provide necessary information about:

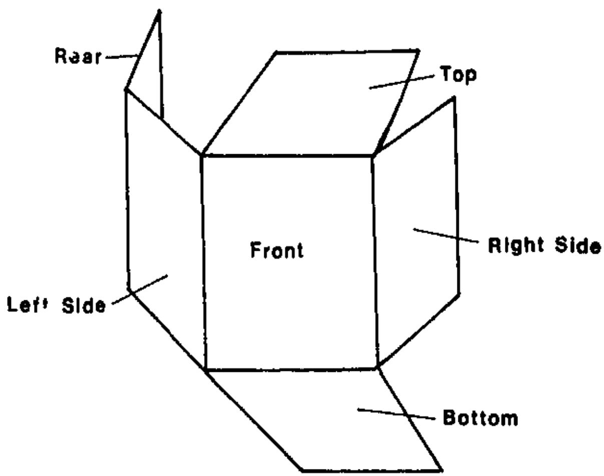
1. Recognize and identify the different types and elements of working drawings, and
2. Interpret, explain and critique examples of various types of working drawings.

rinciples, Examples and Applications

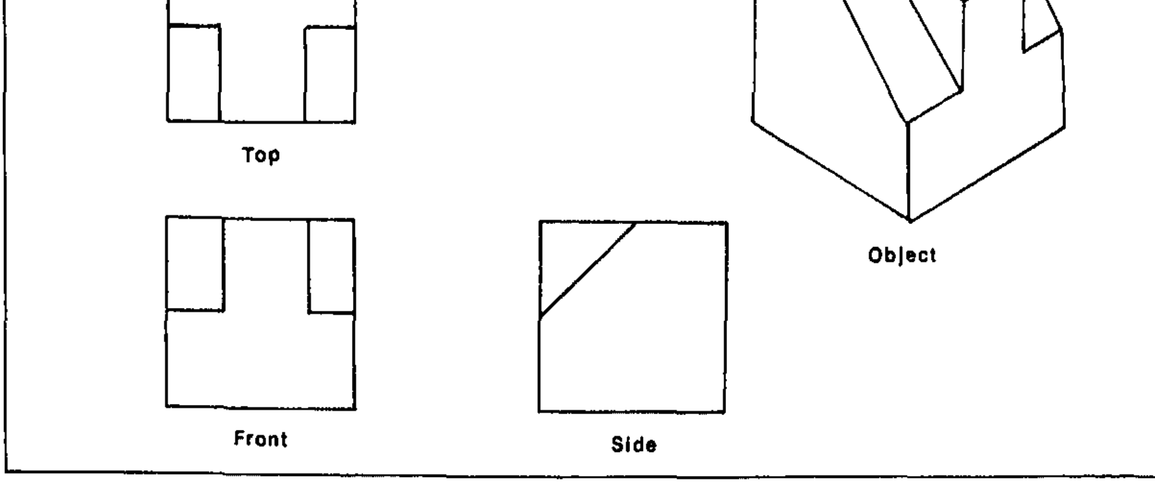
rthographic Projection

Working drawings must show a great deal of detail and information. Therefore, actual pict ually are not suitable. They are too cluttered and confusing. Instead, the most frequently u pe of drawing is the orthographic projection. The orthographic projection is a multiview dr g of an object where each view is at right angles to every other view. The views are projecte t surfaces and do not show perspective.

Figure 12. Planes in an Orthographic Projection



To illustrate what an orthographic projection is, imagine an object like a machine par binet in a clear plastic box. Further, imagine that each side of the plastic box is on hinges so opens out flat on a surface as illustrated in Figure 12. Now, looking straight into each side ding top and bottom, of the box, imagine that you trace the outline of the object in the box

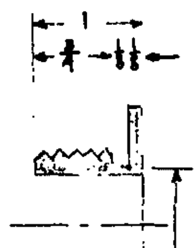


As you examine Figure 13, note that some objects do not require three views in a compl thographic projection. For example, a map or a sphere requires only one view to be compl cylinder requires two views to be complete.

Sectional Views

Sometimes sectional and auxiliary views are necessary to make a drawing clear or usef example, complicated multi-level circuitry or complex parts would be difficult to build w knowing what the object looked like on the inside. Sectional views are made by "cutting" or s the object in two and removing the front half. The drawing illustrates the remaining half of t ject, from the inside out. Auxiliary views show only the principal elements of the orthograph jection of front, top and right side, but are drawn to true size and shape rather than scale. 14 illustrates a sectional view.

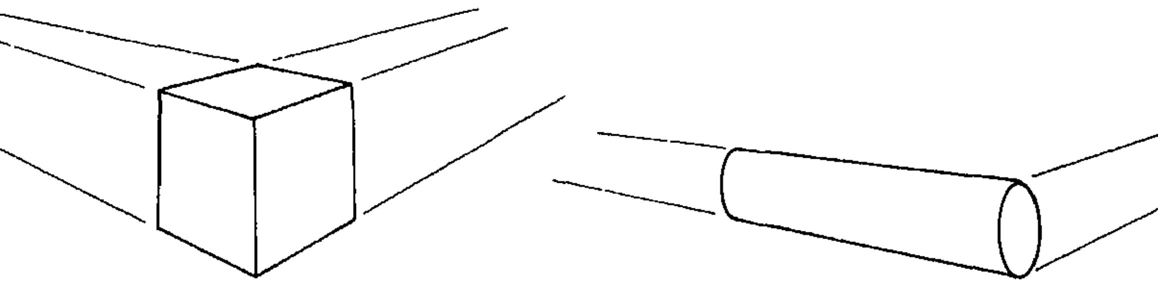
Figure 14. Sample Sectional View



erspective Drawing

The perspective drawing is the most realistic of the three types of pictorial drawin
ased on the fact that objects appear smaller the farther away they are from you as the o
ventually, if the object is long enough—like a highway, fence or railroad track, the objec
ears at the horizon. The point where it disappears is called the vanishing point. Figu
istrates a perspective drawing with an extrapolated vanishing point.

Figure 15. Sample Perspective Drawings



ometric Drawing

Isometric drawings show three surfaces of the selected object, each on a different ax
xis is vertical; the other two are drawn to the right and left at an angle of 30° to the horiz
hat the object can be rotated right or left about the vertical axis. Circles drawn in the is
rm are ellipses. Figure 16 illustrates an isometric drawing and the two axes of an is
rawing.

Figure 16. Isometric Drawing

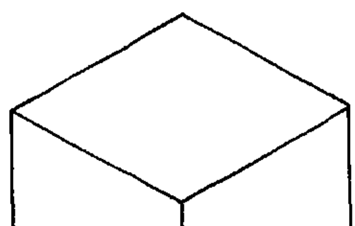
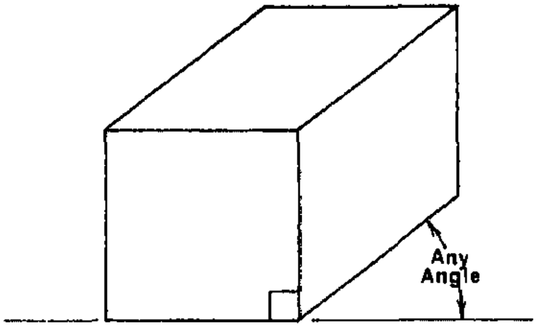


Figure 17. Oblique Drawing



litional Information

'or additional information about types of drawings and views, you may wish to read:

. Lindbeck and I. T. Lathrop. *General Industry, 2nd Edition.* Peoria, IL: Charles A. B
'o., Inc., 1977.

/. Fleming, D. F. Barock and L. C. Smith. *Applied Drawing and Sketching.* Chicag
merican Technical Society, 1950.

-test Exercise

nswer the following questions and check your answers with those provided in the Appe

. What is the primary factor to consider when deciding which views to show orthographic projection?

Answer: ________________

. What views are typically shown in an orthographic projection?

Chapter Overview

Purpose:	To insure that each apprentice has the skill and knowledge to communicate through rough sketches.
Preassessment Score:	Regardless of your score, work through this chapter.
Prerequisites:	Chapter 1, 2, 3 and 4 of this booklet.
Resources:	Time—At least 30 minutes to completion. Materials—pencil, paper.
Performance Statement:	At the conclusion of this unit you will explain and demonstrate the principal techniques associated with sketching lines and objects.
Performance Measure:	A fifteen-minute paper-and-pencil test to be taken after completing the entire booklet.
Standards:	To be successful, you must answer at least 70% of all Posttest items correctly.
Activities:	1. Read the text, examples and illustrations and commit information to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-test Exercises and Posttest.

troduction and Objectives

On the job, sketches made by supervisors, foremen and journeymen frequently are more use an either verbal explanations of how to do something or the formal drawings that illustrate oduct or process. Sketches can be used to highlight certain features of products or proces ch as particularly difficult portions of the product or process or the part of the product or p ss on which people currently are working. In both instances, the sketch defines clearly the te cal information under consideration and explains the specifics of complicated parts ationships.

ciples, Examples and Applications

ching Tools and Materials

ketching tools are simple. All you need is a pencil, an eraser, and paper. In general, use a so
l like a #2 for on-the-job sketching. Harder leads can be used when additional accuracy is r
d. Do not use ballpoint pens because ink lines are difficult to correct if you make a mistake
ge your mind.
aper must be tough enough to endure erasing. Often graph paper or paper covered with som
of grid or lines will help you to draw dimensions.

s and Procedures in the Sketching Process

ketching is a help to describe and explain products, processes, and ideas. Rarely are sketche
n to any scale. However, you should try to maintain some degree of proportion throughou
ketch. The degree of accuracy and detail should be determined by the use of the drawin
mber, the beauty of a sketch is both speed and accuracy.
here are no rules about holding your pencil. Hold it however it is easiest and most comfortab
ou. All you must do is draw lines.

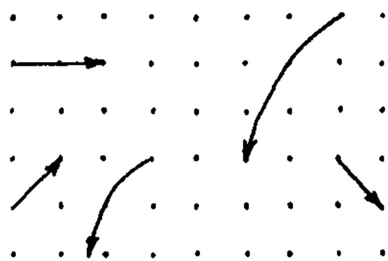
ing Lines

he type and quality of the line you draw is determined by your control of the movement
wrist, fingers, shoulder and elbow. Use arm movement rather than finger and wrist mov
to draw smooth lines. Regulate line heaviness by changing the amount of pressure on th
l. Draw straight lines between two points. Use one point as a starting point and the othe
as a guide to which you draw. The line connects the dots with a quick, easy stroke. Keep you
n the "guide" point. Avoid jerky, wiggly, wavy lines. Usually wiggly lines mean that eith
re using too much finger or wrist movement rather than shoulder or elbow movement or th
rew the line too slowly.
ractice drawing lines on your paper. First place 9 dots on the left side of the sheet. Next, pla

The key to good, straight lines is free arm and elbow movement. Usually it is a good ide
actice the motion of the stroke without touching the pencil to paper. After several pract
aw the line. Practice and freedom of movement result in drawing straight lines.

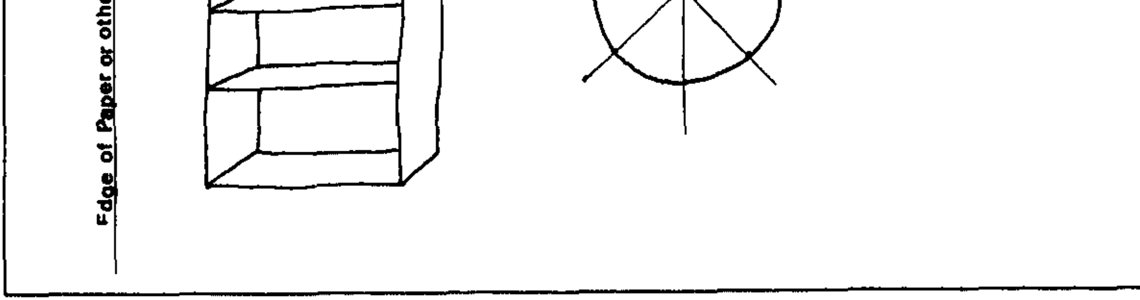
Using Figure 19, draw the lines indicated on the illustration. Notice that, for righthar
ople, the arrow on the sample indicates the preferred direction of the pencil stroke.

Figure 19. Line Practice



etching Objects

Once you have mastered drawing lines, drawing sketches becomes a relatively easy task of
cting various lines to form shapes. The basic procedures are: (1) consider the overall dimensi
the object you will draw and imagine what it will look like on the paper as a way to help work
proportions; and (2) use a series of dots or guidelines to help you get both basic shape
ail through connecting dots. For example, if you are sketching a bookcase or a piece of pape



Additional Information

For additional information about types of drawings and views, you may wish to rea

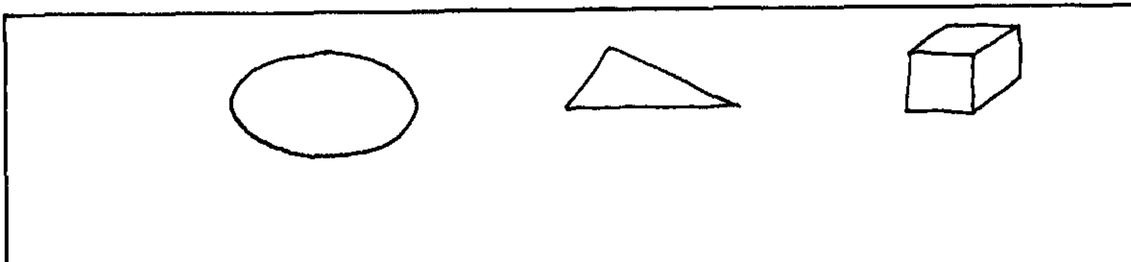
R. S. Oliver. *The Sketch.* New York: Van Nostrand Reinhold Co., 1979.

J. W. Giachino and H. J. Beukeua. *Freehand Sketching.* Chicago, IL: American Technical 1973.

Self-test Exercises

Answer each of the following questions and compare your answers with those provid Appendix of this booklet.

1. Drawing firm, clear lines in sketches usually requires freedom of movement of what the body? Answer: ________________
2. Wiggly lines usually indicate what problems with drawing lines? Answer: ________________ and ________________
3. Draw the figures suggested in the following space:



Chapter Overview

Purpose:	To provide each apprentice with practice in reading shop, assembl and construction drawings and blueprints.
Preassessment Score:	Regardless of your Pretest score, review the content in this chapte
Prerequisites:	Chapter 1, 2, 3, 4 and 5 of this booklet.
Resources:	Time—At least 30 minutes to completion. Materials—pencil
Performance Statement:	At the conclusion of your work in this chapter you will be more con fortable with and conversant in reading blueprints and workin drawings.
Performance Measure:	A fifteen-minute paper-and-pencil test to be taken after completin the entire booklet.
Standards:	To be successful, you must answer at least 70% of the Posttest iten correctly.
Activities:	1. Read the text, examples and illustrations and commit informa tion to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-test Exercises and Posttest.

Introduction and Objectives

Every journeyman must read and use blueprints and working drawings. The skills requ do this are acquired through careful study of blueprints and drawings coupled with the actu of such materials on the job. In most apprenticeship programs you will study intensively s blueprints drawn specifically for your trade. The materials in this chapter serve either as troduction to such study or a refresher about prior learning concerning reading blueprin working drawings. When you have completed your work in this unit you will demonstrat

ing then illustrates how the various parts fit together.

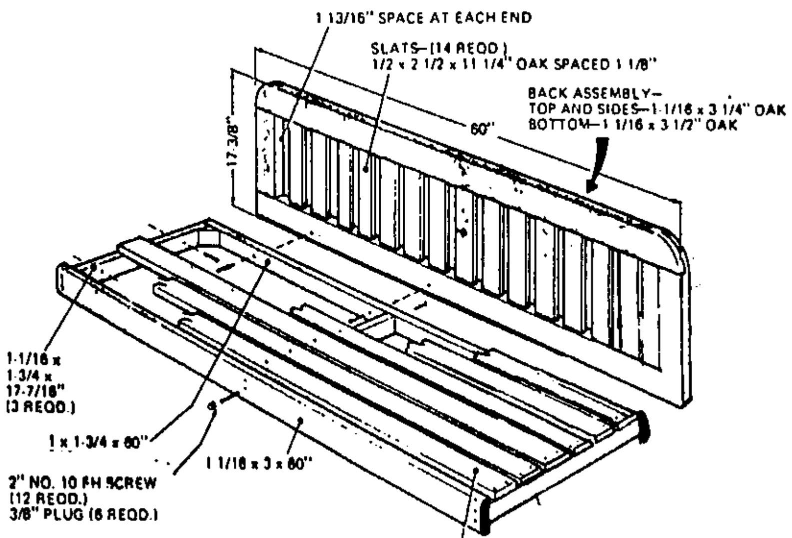
Examine the drawing in Figure 21. This is a sample assembly drawing. Answe questions about the drawing:

1. What is the spacing between the oak slats and the back of the swing? Answer: ________________
2. How many 2″ number 12 screws are required? Answer: ________________
3. What is the length of the swing? Answer: ________________
4. What total length (in linear feet) of 1/2″ x 2 1/2″ oak board is required? Answer: ________________

Answers:

1. = 1-1/8″
2. = 7
3. = 60″ or 5′
4. = Approximately 21'1" or 253"

Figure 21. Example of Assembly Drawing

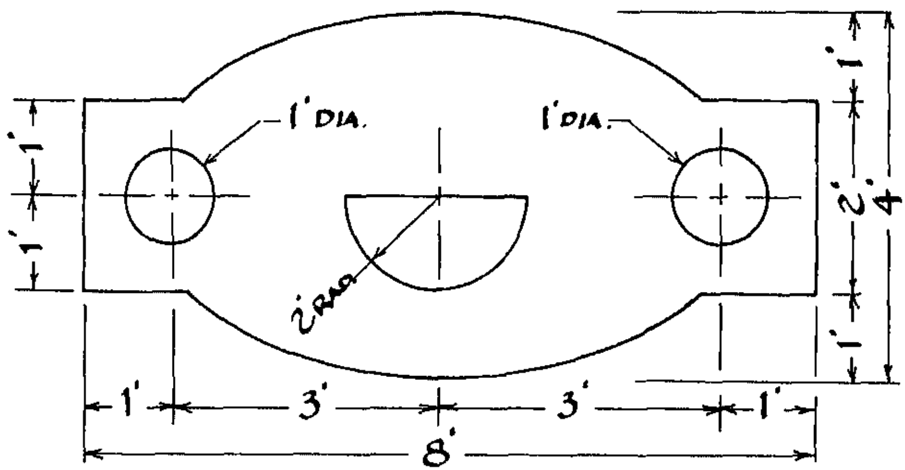


1. What is the radius of the circular holes? Answer: ________________
2. How far is the closer edge of the circular hole to the semicircle in the middle?
   Answer: ________________

Answers:

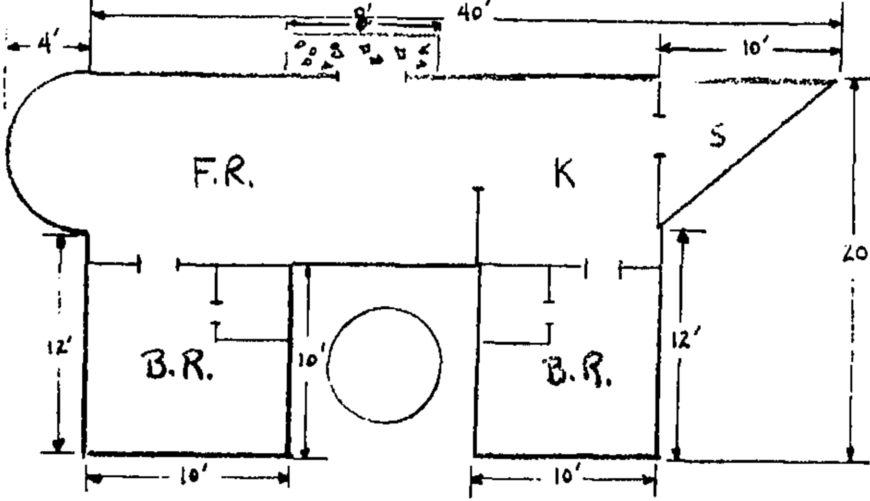
1. = 6″R
2. = 6″

Figure 22. Sample Machine Shop Drawing



You have noticed that several abbreviations are used on the drawings. The more co
used abbreviations on shop and working drawings include:

Blueprint	B/P	Centerline	¢	Head	HD	Screw	SC
Brass	BR	Centerbore	C'BORE	Inside	I.D.	Snug Fit	SN
Bronze	BZ	Centersink	C'SINK	diameter		Standard	ST
Cast Iron	C.I.	Diameter	DIA	Material	MAT	Steel	ST
Cast Steel	C.S.	Finish	f	Pound	#	Thread	TH
				Radius	R.		



1. What are the dimensions of the family room? Answer: ______________
2. What is the width of the house at its widest point? Answer: ______________
3. From what substance is the porch constructed? Answer: ______________

Answers:

1. = 10' x 34'
2. = 20'
3. = concrete

As with shop blueprints, construction blueprints often contain specialized terms and abbre ons that you must memorize. Among the more common terms and abbreviations are:

Angles	<s	Double Strength Glass	D.S.A.	Linoleum	LINOL
Beam	B'M			Living Room	L.R.
Bedroom	B.R.	Frame	FRM	Mortar	MOR

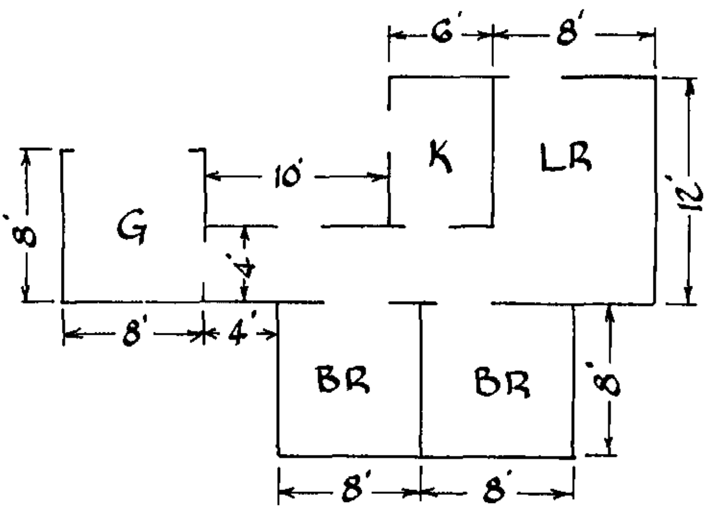
Self-test Exercises

Answer the following questions and check your answers with those provided in the Appe

1. What do each of the following abbreviations mean?

a. COND ________	d. D.S.A. ________	g. REC. ________
b. B/P ________	e. <s ________	h. L.R. ________
c. C'SINK ________	f. DIA ________	i. # ________

2. Examine the following drawing. What are the dimensions of the kitchen?



Answer: ____________

3. What is the area in square feet of the living room? Answer: ____________

Answers to Pretest

1. Hidden edge
2. Dimension and Extension
3. a
4. d
5. To illustrate large distances
6. The ratio of a drawn object to its actual size.
7. Size and location
8. The diameter of the hole is .5 inches, plus or minus one one thousandth of an inch
9. b
10. All five items should be checked
11. b
12. c
13. d

Answers to Self-test Exercises

Chapter 2: Lines, Symbols and Lettering

1. a. = 3, b. = 1; c. = 2
2. a. = 4; b. = 2; c. = 1; d. = 3
3. A E G

Chapter 3: Scales and Dimensions

1. Size of object
2. To fit on page; to provide sufficient detail; to show interrelated parts.
3. Five inches
4. Many rules have been violated including:

Chapter 5: Sketching

1. Shoulder, elbow and arm
2. *Either the line was drawn too slowly or with too much use of fingers and wrists.*

Chapter 6: Reading Blueprints

1. a. Conduit
   b. Blueprint
   c. Countersink
   d. Double strength glass
   e. Angles
   f. Diameter
   g. Recessed
   h. Living room
   i. Pound
2. 7′ x 8′ *or 56 square feet*
3. 112 square feet

portions of this booklet with which you had difficulty.

1. Dimension provides information about what elements of design?

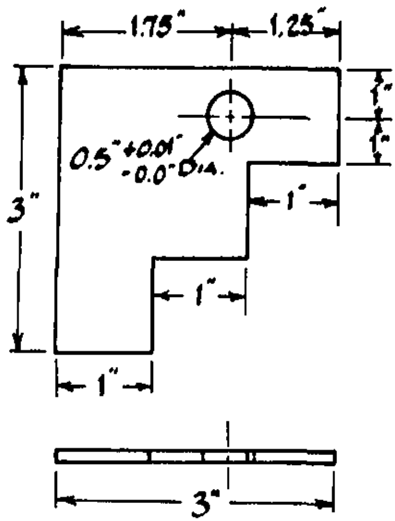
   Answer: ______________________________

2. What does the following type of line mean?

   Answer: ______________________________

3. What does the following dimension mean for tolerance of the hole?

   Answer: ______________________________

4. Why are some drawings of some objects made larger or smaller than the actu

   Answer: ______________________________

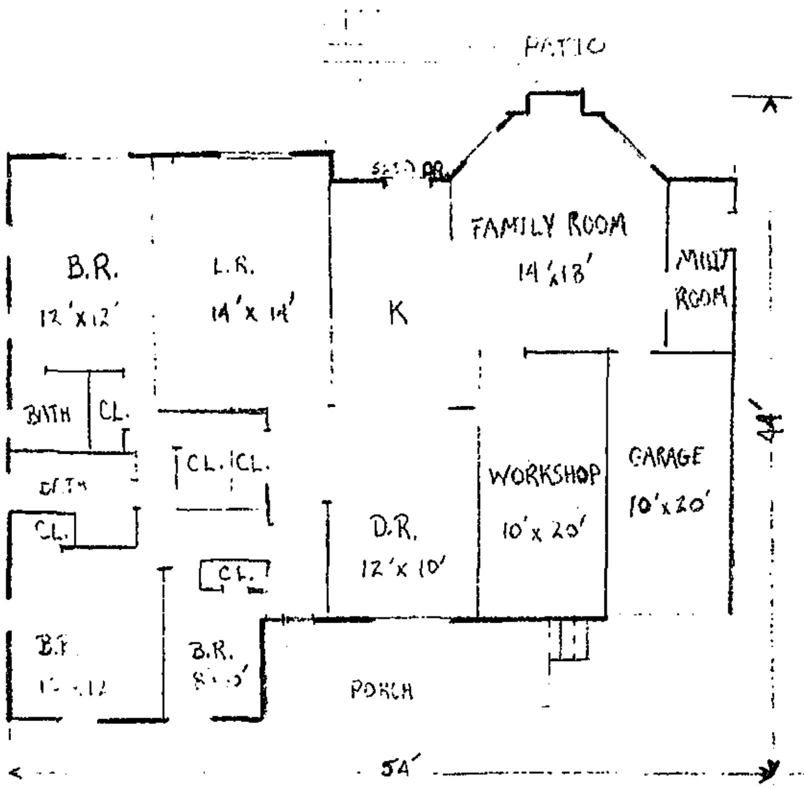
5. Most orthographic projections provide three views. What are they?

   Answer: ______________________________

6. Wiggly lines in drawings usually indicate what types of problems?

10. What are the dimensions of the garage?

Answer: ______________________________



3. Tolerance can be 0.01 longer, but 0.0 smaller than 0.8" DIA.

4. To fit on page, provide sufficient detail; to show interrelated parts.

5. Front, top and right side.

6. Either the line was drawn too slowly or with too much use of fingers a

7. a. Diameter b. Inside diameter

8. b .

9. 354 sq. feet.

10. 10' x 20 '

Scoring

Each question counts 1 point. You must answer at least 7 questions correctly to
work in this booklet.